SAT

SESSION 1

S12.01 - The Mediterranean
SATURDAY, August 21, 2004 - 9:00
Room: 1 - Cavaniglia

Conveners:

Mascle Jean, Sartori Renzo (†), Zitellini Nevio

1-1 Invited Ryan, William B. F.

THE MEDITERRANEAN TETHYS AND THE DEVELOPMENT OF NEW CONCEPTS OF TOP-DOWN TECTONICS

RYAN William B. F.[1], MALINVERNO Alberto[2]
1 - Lamont-Doherty Earth Observatory of Columbia University
2 - Schlumberger-Doll Research

Keywords: Mediterranean; Tethys; Plate Tectonics; Subduction

The Mediterranean and its ancestor Tethys Sea have been both the inspiration of and the testing ground for many geological concepts. Rather than attempt an historical perspective, this talk will show how tectonic ideas have built one upon the other in a quest for how our planet works. To understand the opening and closing of Tethys we journey from geosynclines to plate tectonics to active deformation derived from satellite geodesy. In today's Mediterranean we search on the passive margins of the Levant for the subsidence required to accommodate the thick sedimentary bodies caught up in the Alpine mountain belt, in the Calabria and Mediterranean Ridge accretionary prisms for the physical mechanism to create nappes, on the floor of the Tyrrhenian Sea for the birth of the ophiolite assemblage, in Calabria for a way to rapidly exhume extreme-pressure metamorphic rocks, in the Pliny and Strabo trenches as an example of a plate boundary evolving new geometries to minimize friction and work, and in the Aegean and Aeolian Arcs for a coherent pattern behind the diverse chemistry of calc-alkaline volcanism. The quest for driving forces takes us away from a bottom-up, mantle-centric view of convection currents transporting the ocean and continental lithosphere as passive passengers on conveyor belts. Instead we go to a new top-down tectonics in which the plates act as a template to organize mantle convection and produce slab push, pull and rollback. Using the hotspot reference frame the closure of Tethys will be presented in steps as an example where subducting slabs and cratonic roots have acted as the template for the Mediterranean child.

1-2 Invited Vai, Gian Battista

THE MEDITERRANEAN AREA AS - OF MIDDLE MIOCENE-TO-RECENT CHRONOSTRATIGRAPHY

VAI Gian Battista[1]
1 - Dip. Scienze della Terra e Geologico-Ambientali

Keywords: stages; standard stratotypes; GSSP; astrochronometry; Italy

Neogene-to-Quaternary chronostratigraphy dates back to the father of modern geology, Charles Lyell (1833, 1839). Where from did Lyell derive his original Greek-etymon-related classification? As for *stratum typicum*, it was based upon the Macigno sandstone (Aldrovandi, 1642; Targioni-Tozzetti, 1751), the Subapennine clay (Brocchi, 1814) -in turn subdivided into Blue clay (Leonardo, 1506-10) and Yellow sand (Beccari, 1711)-, and the Diluvium terrain, a term used throughout Europe. As for *locus typicus*, most of the sites were designated in the Mediterranean areas, mainly in Italy and on Italian islands. Invariably, all historical type localities and stratotypes of post early Miocene marine stages and substages were placed in the Mediterranean countries. Standard stages and substages such as Langhian, Serravallian, Tortonian, Messinian, Zanclean, Piacenzian, Gelasian, Calabrian (Santernian, Emilian, Sicilian), Crotonian or Ionian, Tyrrhenian or Tarentian, and Versilian are all based on Italian stratotypes. The Zanclean (Pliocene), Piacenzian, Gelasian, Calabrian (Pleistocene-Quaternary) are defined by golden spikes located in Italian sections. The Messinian GSSP only is defined outside Italy in the Atlantic Moroccan hills. The abundance in Italy of standard chronostratigraphic sites reflects the primacy reached by Italian and foreign scholars active in Italy from the 16th to the 19th century when modern geology developed. It also underscores the excellent exposures illustrating the geological processes of sedimentary, volcanic, magmatic, tectonic, and metamorphic type found in Italy. Changing paradigms and techniques in geology has not changed the importance of the Italian and Mediterranean regions for standardizing chronostratigraphy. The recent developments in astronomically-forced high-frequency sedimentary cyclicity occurred starting from sections exposed in Calabria, Sicily and the Apennines. It established a high-resolution astrochronometric time scale for the Neogene and Quaternary precisely calibrating their stages and substages. Thus, the time resolution of the concurrent geological processes has increased to the level of tens of ka. Short term evolutionary trends, high-frequency nearly-historical climatic/eustatic changes, and high-velocity tectonic phases may be detected by this new chronological tools improving the modelling of global changes for the benefit of human kind.

1-3 Invited Mascle, Jean

THE MEDITERRANEAN SEAFLOOR

MASCLE Jean[1], LOUBRIEU Benoit[2]
1 - CNRS-GEOSCIENCES-AZUR, VILLEFRANCHE sur MER, FR
2 - IFREMER/DRO GM BREST, FR

Keywords: Swath Bathymetry; Sea floor; Mediterranean sea; Sedimentation; Tectonic

Since the last decade systematic swath mapping surveys (bathymetry and often backscatter images) have been conducted in the deep Mediterranean sea, particularly in its eastern and in its westernbasins. These data, collected in the framework of national programs for knowledge of their EEZ, have uncomparable value for a better understanding of the many active processes presently shaping thesea floor of the deep Mediterranean sea.In 1999 CIESM and IFREMER has initiated a program based on voluntary partners to compile, at a scale of 1/1.500.000, and at a 500m grid spacing, a general DTM of the Eastern Med basins. This map,already published, has demonstrated the sartling changes brougth to our knowledge and understanding of the deep basins, and their surrounding continental margins, by mapping using swath bathymetrictools. For example the deformationnal style, the impact of massive fluid emissions and mud volcanism over most of the Mediterranean ridge, have been illustrated and can now be studied at a scaleimpossible to reach before. The several active sedimentary (channel-levee systems, mass wasting) tectonic (salt tectonic),geochemical (fluid emissions) processes operating on the Egyptian margin andconcurring to the edification of the Nile deep sea fan, have been particularly well evidenced. We present here and comment a new synthesis of the Eastern Med. basins upgraded using the most recentavailable data from two surveys conducted in 2003 by french groups. This map has also been completed for the Aegean sea by data from HCMR (Greece). We also comment on the first draft of asynthesis, with the same grid spacing 500 m) of the Western Mediterranean basins. This compilation has been made possible through a cooperation between several Institutions (Ifremer,CNRS, IUM-Brest and Univ.Paris 6, France, Ismar from Bologna for Italy, IEO, GRC, IACT respectively from Madrid, Barcelona and Grananda for Spain). It also shows, at a global scale, many of the characteristics,particularly slope sedimentary processes and magmatic activities which are shaping the floor of the Western Mediterranean sea continental margins or of its very recent basins such as the Tyrrhenian sea.Finally, we are also briefly introducing a compilation of the entire Mediterranean sea, at a scale of 1/4.000.000, which will probably be the first multibeam bathymetric map of a complete oceanic space andof its surrounding continental margins

1-4 Invited Chamot-Rooke, Nicolas

PRESENT-DAY KINEMATIC FRAMEWORK OF THE MEDITERRANEAN

CHAMOT-ROOKE Nicolas[1], KREEMER Corné[2], LE PICHON Xavier[2], BARRIER Eric[3]
1 - Laboratoire de Géologie, Ecole normale supérieure, Paris, France
2 - Collège de France, Europole de l'Arbois, Aix en Provence, France
3 - Laboratoire de Tectonique, Université P. & M. Curie, Paris, France

Keywords: Mediterranean; Plate Kinematics; Plate Tectonics; Mediterranean Basins; Active faults

Our knowledge of the present-day Mediterranean kinematics has been greatly improved by the accumulation of geodetic measurements during the last decade. We review here some of the significant new results and their geodynamic implications. The present-day crustal motion in the Mediterranean involves interactions between three major plates : Eurasia, Nubia (i.e. Western Africa) and Arabia. Nubia geodetic motion is small with respect to Eurasia (4 mm/yr in Gibraltar to 6 mm/yr in Cyprus), and is 2 to 4 mm/yr smaller than predicted by the 3 Myr geological plate model (Nuvel-1A) and slightly west of it. In the Western Mediterranean, this NW convergence is accommodated along the North Africa plate boundary, probably partly in the Tellian Atlas and partly along the southern margin of the Algero-Provençal basin. Shortening is absent in the Alpes and Nubia convergence is thus accommodated further south, along the Calabro-Sicilian front. The 5 mm/yr convergence there contrasts with the high 35 mm/yr rate along the Hellenic subduction, which is a consequence of the rapid west and southwest escape of Anatolia and Aegea respectively. The nearby position of the rotation pole for Anatolia implies a corresponding progressive decrease of the convergence towards Cyprus. Sharp transition from slow convergence to high subduction rate occurs along the Kefallonia right-lateral transform and its continuation at sea, which is also the boundary between the Calabrian and Mediterranean wedges. On land, the northern boundary of the Anatolia block follows the North Anatolian fault which is close to pure right-lateral at a constant rate of 25 mm/yr. The tip of the fault, propagating westward during the last 5 Myr, has reached the North Aegean Trough but does not connect yet to the young (1 Myr) and actively extending (10 mm/yr) Corinth Gulf. A striking picture of this Mediterranean framework, using kinematics and seismicity, is that blocks of various size seem to behave coherently at present time (Adriatic, Aegea, South Marmara, Anatolia, Sinai, South Caspian, Central Iran, ...). Truth or fiction on geological timescale ?

1-5 Invited Mauffret, Alain

EVOLUTION OF THE WESTERN MEDITERRANEAN BASIN

MAUFFRET Alain[1]
1 - CNRS-INSU-Univ Paris 6

Keywords: Western Mediterranean Sea; Active Margin; Tertiary evolution

The Western Mediterranean Basin has been formed at the active convergent boundary between the European and the African Plates. There is an obvious difference in age and structure between the Northern and the southern basins. In the north the Miocene is 4 km thick whereas it is much thinner (2 km) in the south. Therefore we propose that the southern Basin is younger (mid-Miocene) than the northern basin (early Miocene). The Northern Basin is a back-arc basin that opened behind the arc, which is located along the western margin of Corsica, in Sardinia and north of Balearic Islands. The early Miocene southern Basin was a mixture of continental blocks (Apennines, Calabria, Kabylies, Rif and Betics) fore-arc basins (Eastern Corsica, Eastern Sardinia, Western Alboran basins) and accretionary prism. At this time the Rif, Betics and the Western Alboran Basin were located south of the Balearic Islands. The coeval early Miocene extension of the continental crust in the Valencia Trough, the Western Alboran Basin and a probable equivalent Kabylian Basin was sufficient to bring the Kabylies at the contact with Africa without creation of oceanic crust. After the collision of the Kabylies and Africa Plate during the Burdigalian, the Alboran Block and the Apennines drifted towards the west (Atlantic Ocean) and east (Adriatic and Ionian Sea) respectively. After the Burdigalian (16 Ma) the oceanic crust of the Algerian Basin is created by the rolling back of the Gibraltar Arc with a high rate of spreading (5 cm/year) in an E-W direction. An extinct spreading centre, that we named Hannibal Ridge, is presently located between Menorca and Algeria. This ridge is not covered by the thick Messinian salt and several volcanic features are identified. We suggest that the extinction of the spreading centre occurred during the Tortonian (8 Ma). At this time the compression resumed in the Alboran Sea area and Northern Algeria. The present boundary between Europe and Africa Plates, where destructive earthquakes are frequent, is located along the Algerian margin with a right-lateral transpression. The North-African Margin is rethickened with a double vergence. The southern boundary is characterized by northwards verging thrusts (El Asnam area) whereas the northern boundary is formed by southwards thrusts (Algiers area).

1-6 Invited Scandone, Paolo

NEOGENE-QUATERNARY EVOLUTION OF THE CENTRAL MEDITERRANEAN REGION

SCANDONE Paolo[1], PATACCA Etta[1]
1 - Dipartimento di Scienze della Terra dell'Università di Pisa

Keywords: Neogene-Quaternary; evolution; Central Mediterranean region

Mountain building, continent-continent collision and post-collisional opening of back-arc basins are the result of geological processes obviously controlled by plate interaction. In the case of the Central Mediterranean region, the kinematic system describing the interaction between the Europe and Africa plates is closely controlled by the kinematic system describing the evolution of Central and North-Atlantic Ocean. Kinematic models derived from the analysis of the Atlantic magnetic anomalies predict in the Mediterranean region slip vectors acting through Tertiary times that fit very well a lot of first-order observed tectonic structures, mostly in the Alps. The same slip vectors, however, do not justify the development in Neogene and Quaternary times of important geological features such as the Western Mediterranean basin, the Tyrrhenian basin, the Southern Apennines and the Calabrian Arc. These vectors, in fact, appear incompatible both in the magnitudes and in the directions with the vectors reconstructed by

regional geology that describe the displacement path the investigated geological objects. The occurrence of such large-scale structural features that appear incompatible with the Atlantic-derived kinematic constraints can be justified by different geodynamic processes, the most important of which is certainly represented by the roll-back of down-going lithosphere in subduction zones (the latter do not necessarily coincide with convergence zones) producing rapid flexure-hinge retreat of the lower plate. The roll-back of a subducting lithosphere appears to be the only mechanism able to modify the Atlantic-versus-Mediterranean kinematic balance by adding in the system new source areas and new sink areas.In our presentation we will illustrate some well documented case histories in which maximum flexure-hinge retreat developed at about 90° with the Atlantic-derived slip vectors and in which the Africa/Adria subduction rates computed from the amount of extension in the back-arc basins, from the flexure-hinge retreat in the forward-migrating foredeep-foreland system and from the amount of shortening in the thrust belt system reached values three or four times greater that the values predicted by the Atlantic-derived models.

1-7 Invited Petit-Maire, Nicole

THE MEDITERRANEAN BASIN DURING THE LAST CLIMATIC EXTREMES

PETIT-MAIRE Nicole[1], BRUGAL Jean-Philippe[1], BRACCO Jean-Pierre[2], BUROLLET Pierre F.[3], COUDE-GAUSSEN Geneviève[4], JALUT Guy[5], LERICOLAIS Guy[6], PANATTONI Raymond[1], VAN VLIET-LANOE Brigitte[1], VRIELYNCK Bruno[1]
1 - CNRS
2 - Universite Aix
3 - Retraité
4 - Université Caen
5 - Université Toulouse
6 - IFREMER

Keywords: Climate; Mediterranean Basin; Maps; Environment; Quaternary

Pluridisciplinary radiocarbon dated information on geological formations, vegetation, fauna and human habitats have therefore been grouped on two maps at 1/5 000 000 scale figuring two key-periods : the Last Glacial Maximum and the Holocene Warm Optimum.Those documents (already realised for the World and France) are meant to provide the specialised scientists with a pluridisciplinary view, especially upon the interactions between Climate and Man. They may also help to inform the political and institutional actors of the regional benefits or dangers tied to climatic change. Last, but not least, a wide non-scientific audience may understand, through those simple visual documents, the importance of a few degrees C difference for our way of life.It is moreover important to know the natural variability of the environments in order to delimitate the respective roles of Nature and of Man in the current climatic change and to consider our possible futures, either towards a new glacial or towards a major global warming.

1-8 Invited Beccaluva, Luigi

CENOZOIC VOLCANISM AND TECTONO-MAGMATIC EVOLUTION OF THE CENTRAL-WESTERN MEDITERRANEAN AREA

BECCALUVA Luigi[1], BIANCHINI Gianluca[1], SIENA Franca[1]
1 - Dipartimento di Scienze della Terra, Università di Ferrara, 44100 Ferrara, Italy

Keywords: Cenozoic Volcanism; Tectono-magmatic evolution; Mediterranean

The Cenozoic Volcanic Provinces of the central-western Mediterranean area belong to two main tectono-magmatic associations: 1) orogenic, subduction-related volcanism in Sardinia (Oligo-Miocene), Eolian Arc, and Roman Magmatic Province (RMP); 2) anorogenic suites in Sardinia and Iblei-Etna-Sicily Channel (Neogene-Quaternary), as well as Veneto Volcanic Province (Paleogene). The space-time distribution and petrogenetic affinity of orogenic magmatism from Provence/Sardinia to the Eolian Arc and RMP, can be best accounted for by a single "evolutionary process of subduction", starting from the Middle-Late Eocene beneath the Paleo-European continental margin and migrating southeastward with time through the opening of the Ligurian-Balearic and Tyrrhenian interarc oceanic basins. The petrological and isotopic features of the Quaternary orogenic magmas along the eastern peri-Tyrrhenian border - namely, their general evolution from calcakaline to shoshonitic and ultrapotassic products - are to be related to an accentuated steepening and retreat of the subducted lithosphere, with increasing involvement of terrigenous sediments from the Eolian area to the Campanian and Roman Provinces. The ca. 800-km long lithospheric slab consumed during the entire subduction process is in agreement with recent tomographic data which depict the Ionian lithosphere currently dipping beneath the Aeolian-Calabrian arc as a single body flattening in the upper mantle at around 670 km beneath the Tyrrhenian basin and the adjacent Sardinia block. Extension-related anorogenic volcanism of Iblei-Etna-Sicily Channel and Veneto mainly consists of basic magmas ranging in composition from tholeiites to Na-alkali basalts/hawaiites, basanites and nephelinites. In Sardinia, the Pliocene-Quaternary volcanism produced comparatively more potassic magmas: from subalkaline basalts, alkali basalts/trachybasalts to basanites, locally associated with rhyolitic and phonolitic differentiates. The ubiquitous presence of the HIMU geochemical component in all these volcanic products, irrespective of their belonging to the European or North African domains, lends support to the existence of a Cenozoic asthenospheric mantle plume - supposed to extend from the eastern Atlantic to Central Europe and western Mediterranean - which could therefore represent the provenance of this component.

1-9 Invited Alonso, Belén

SEDIMENTARY PROCESSES: THE DEEP SEA

ALONSO Belén[1], ERCILLA G[1]
1 - CSIC, Instituto de Ciencias del Mar, Paseo Marítimo de la Barceloneta

Keywords: sedimentary; processes; deep sea

During the last years important advances and challenges have occurred in the understanding of the deep water sedimentary processes. It is justified by the recent discovery of giant hydrocarbons fields in deep offshore and recent development of well-integrated techniques of deep sea floor. The different sedimentary processes to produce a model of deep sea sedimentary systems growing could be grouped into three categories based on the pathway that they operate to deliver sediment into deep water: downslope, alongslope, and vertical flux. Downslope processes dominate in the Mediterranean and comprise at least the following types of sediment transfer: creeps, slides, mass flows, (mega)turbidity currents, and hyperpicnal turbid plumes. The importance of these processes range in frequency, space and time, resulting in sedimentary systems, such as canyons, channels, gullies, fans, mid-ocean channels, and a great variety of mass-wasting deposits, displaying different geometry and internal pattern. The alongslope processes are mainly related to the action of the Mediterranean Current that sweeps the distal continental margins and deep sea basins, influencing both sediment deposition, erosion and reworking. These processes are responsible of contourite drifts, scours, and fields of sediment waves (e.g. Ceuta, Corsica, Paola, Cefalu, Sicily, Messina). Finally, the hemipelagic fluxes are responsible of hemipelagites, being the deep sea basins the preferential depositional environments. In addition to these three categories of sedimentary processes, the fluid escapes are another type-venting processes noted in the Mediterranean (e.g., Alboran Sea, south of Cypurs, southwest Turkey). Mud volcanoes, pockmarks and hydrocarbon seeps which support chemosymbiotic organisms are attributed to these processes.

1-10 Invited Trincardi, Fabio

SEDIMENTARY PROCESSES: CONTINENTAL-SHELF AND COASTAL AREAS

TRINCARDI Fabio[1]
1 - ISMAR (CNR) Bologna

Keywords: Deltas; Sand ridges; Lagoons; Sea level change; Late Quaternary

A glimpse at the modern Mediterranean coasts shows coastal-plain deltas experiencing regression as well as estuaries and barrier-lagoon systems reflecting sediment starvation and transgression. Quaternary continental shelves and coastal areas record the impact of relative sea level changes as well as the influence of fluctuations in sediment supply. Relative sea level changes (their positive or negative sign and their rates) define the accommodation space made available for sediment fill and represent a complex function of eustatic change, regional tectonics (subsidence, uplift and related margin tilt) sediment loading and compaction. Modern Mediterranean continental shelves reflect the legacy of the rapid sea level rise that took place during the last glacial-interglacial transition. Sand patches on shelves reflect the location of drowned coastal deposits formed and variably reworked during the step-wise sea level rise. While accommodation changes are well documented, the impact of changing sediment flux to nearshore areas is far less defined. The late Holocene is an interval of relatively stable sea level when the impact of short-term changes in sediment flux can best be quantified. By reviewing the short-term stratigraphic evolution of late-Holocene Mediterranean depositional systems, it is possible to 1) define how observable depositional events (such as river floods) affect the construction of near-shore sedimentary bodies and 2) place the evolution of shallow-water systems in a more comprehensive source-to-sink frame. In particular, where regression is dominant, modern prodeltas represent a crucial link between coastal and shelf environments. Prodeltas are large shallow-marine features characterised by significant mud accumulation (10's of m), below storm wave base. Therefore prodelta deposits are one of the best sites recording supply fluctuations including those driven by the impact of humans from pre-history to industrial times. Ongoing research on Mediterranean prodeltas is generating extensive databases for a variety of practical and scientific purposes. These databases can be integrated to reconstruct the recent growth of prodelta systems from river-flood dynamics (magnitude, recurrence, offshore impact), to physical stratigraphy in shallow waters. This data integration also includes key information from historical maps constraining the phases of delta construction in the last few centuries, to better evaluate climate and human forcing.

1-11 Invited Muttoni, Alda

HYDROCARBON POTENTIAL IN THE MEDITERRANEAN BASINS

BELLIDORI Marcella[1], CASADIO Lucio[1], FANTONI Roberto[1], MUTTONI Alda[1], POERIO Leonardo[1], QUAGLIAROLI Filippo[1], SOLLEVANTI Federico[1]
1 - ENI E&P

Keywords: Mediterranean basins; Petroleum system; Hydrocarbon exploration

The Mediterranean region is a very complex geological area as part of a long lived continental collisional zone characterized by several openings and closings. The complex geological evolution originated different petroleum systems and is the reason of a diversified exploration history still in progress. The area can be divided in three sectors: Western, Eastern and Central.The Western sector is characterized by a recent extensional tectonics where basins have been developed on oceanic crust or continental thinned crust. The petroleum potential is limited and mainly represented by biogenic gas.The Central sector has been subjected to the interference of orogenic systems (Alps, Dinarides, Appennines) as well as to polyphasic extensional stages (Mesozoic and Neogene) showing a very complex structural framework. In this context clastic sequences belonging to foreland and foredeep domains are biogenic gas bearing in plio-quaternary and mainly thermogenic gas bearing in oligo-miocenic series in stratigraphic and/or structural traps due to the Tertiary compression.The carbonatic Mesozoic succession is filled by oil and thermogenic gas in structural traps connected to the Mesozoic extensional and/or Tertiary compressional phasesTunisian-Libyan offshore stable margins of the African Plate extension (Pelagian Sea and Sirte Gulf) where the main reservoir is represented by the Tertiary carbonate sequences and Aegean Sea back-arc basin, marginal for petroleum exploration, belong to Central Mediterranean area too. The Eastern sector is southward represented by the continuation of the stable African margin; only in correspondence of Israel and Liban offshore the tectonic activity is dominated by intense wrench faulting. Northward tectonic is controlled by convergence between African and Eurasian plates. The thicker sedimentary sequence of Nile Delta is the main hydrocarbon province in the sector (gas and/or condensate).The exploration begun in onshore in 1860 and in offshore in 1959 (Gela Mare 21, first offshore well in Europe). In 1993 Aquila oil field was discovered in 850m water depth. Seismic and drilling technology improvements have allowed the extension of exploration's areas and the achievement of deeper targets in frontier areas. Unceasing changing in the economic scenarios forces to a detailed assessment of potential in both new plays and residual exploratory areas. The technology improvement is the driving element in the exploration for future resources.

1-12 Invited Piccardi, Luigi

THE MEDITERRANEAN AS THE BIRTHPLACE OF MYTHS IN THE WESTERN WORLD

PICCARDI Luigi[1]
1 - C.N.R. - Institute of Geosciences and Earth Resources, Via G. La Pira 4, 50121 Firenze, Italy

Keywords: Mediterranean; geomythology; fault-related sanctuaries; Apollo; Archangel Michael

Geologic phenomena and aspects have always kept a central role in myths. The reconstruction of mythology backwards to Paleolithic indicates that for more than 30.000 years the principal divinity was the Great Mother Goddess, Lady of life as well as of death. Rituals and cults then were directed not upwards to Heaven, but downwards to Mother Earth. It isn't therefore surprising that much attention was paid to geologic phenomena, and in particular to the ones more connected with the underworld, like volcanoes or earthquakes. Such impressive phenomena, which aroused awe and wonder, affected right the nucleus itself of human existence: the womb of Mother Earth, alpha and omega of every living creature.With the shift to male divinities (5th-2nd millennium BC) the manifold aspect of the Great Goddess endured into the various divinities, and the connections with geology were maintained.Two of the cults most relevant to the western society, those of Apollo and of Archangel Michael, provide examples of